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Nonlinear microwave absorption in $Ba_{1-x}K_xBiO_3$

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Nonlinear, field-modulated, direct microwave absorption (FMMA) was observed in copper-free $Ba_{1-x}K_xBiO_3$ powder samples. The high-field, low-temperature results were compared to previous measurements of YBa CuO and BiSrCaCuO. The microwave determined critical field $\mu_0 H^* = 0.7$ μT and depinning current density $J_c^* \approx 1 \times 10^7$ A/m^2 were obtained from the "Portis" model of flux pinning and depinning. These values were lower than the values obtained previously for YBaCuO and BiSrCaCuO as anticipated for a material with larger coherence length and comparable London penetration depth. A previously unobserved asymmetry of the FMMA in the field scan direction was also noted.

1. Introduction

Microwave absorption (MA) measurements provide important information on selected properties of high-T_c superconductors (HTS's). In addition to established surface impedance measurements [1,2], investigations have been extended to include MA under the influence of time-varying magnetic fields [3–12]. The direct observation of the hysteretic MA as a function of field is a rapidly obtained indicator of the superconducting state. In addition, one can readily extract a critical field H^* and obtain a critical current density from the field gradient $H^*/\lambda_m = J_c^*$, where λ_m is the length scale of the field change in the HTS dictated by the pinning properties. Here, MA measurements in high-T_c $Ba_{1-x}K_xBiO_3$ (BKBO) are presented. Although this isotropic, cubic system possesses similar features to copper based, layered HTS's (e.g. a perovskite-type structure), differences do exist which are important for the MA. These distinctions include a comparatively long superconducting coherence length ($\xi(T=0) \approx 5.8$ nm) [13]. A comparison of the MA in different HTS systems can provide insight on how intrinsic properties, such as coherence length and anisotropy, place essential limits on the pinning energies.

So far no definite model has been proposed which can account for all the experimentally observed features of MA under the influence of time-varying magnetic fields. Although the proposed models described below only differ in subtle ways in their predictions of the MA, they are based on two different mechanisms of microwave losses. These are the losses due to viscous motion of fluxons and the losses in the weak-links medium. Further experiments are required to gain insight into the mechanism of MA and to establish the appropriate model of MA in HTS's.

2. Samples

Powder samples of BKBO were prepared using the two-step heating method by Cava et al. [14]. The starting oxides BaO, KO_2, and Bi_2O_3 were mixed in high-quality silver tubes in the stoichiometric perovskite ratios by adding 100% excess KO_2. This mixture was heated for three days at 675 °C and then annealed in oxygen at 475 °C for 45 min. From magnetization measurements the critical temperature was found to be $T_c \approx 30$ K and the transition width was rather broad ($\Delta T_c \approx 14$ K, 90–10% criterion).

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